

STORMWATER MANAGEMENT REPORT

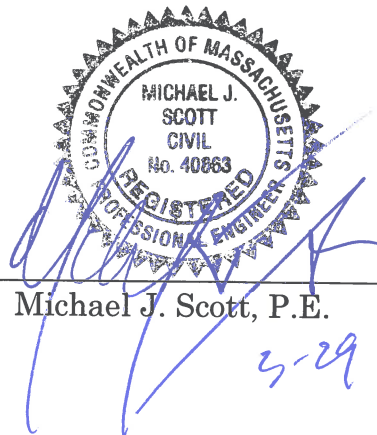
for:

Equine Arena
Willard Road
North Grafton, Massachusetts

Project Proponent:

Cummings School of Veterinary Medicine
at Tufts University
North Grafton, MA 01536

March 2016



Michael J. Scott, P.E.



WATERMAN DESIGN ASSOCIATES, INC.

31 East Main Street • Westborough, MA 01581

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PURPOSE

Hydrologic, hydraulic, and water quality calculations have been performed as part of the Project Plan Review, a proposed redevelopment project located in North Grafton, MA. The calculations were performed to design stormwater collection and attenuation facilities for the site and to demonstrate that the project will meet the standards of the Town of Grafton and the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Regulations.

This report describes the existing project site, the proposed project, and analyses performed to develop a stormwater management system that will protect public safety and convenience and minimize environmental impacts.

PROJECT SITE

The Project Site contains four (4) plus acres of the Tufts Campus on the west side of Willard Road and south side of Westboro Road. The northern portion of the project site (approximately 1 acre) is presently under construction to complete an earlier expansion of the small animal hospital building. The remainder of the project site contains a number of horse paddocks and other yard areas for animals. There are no wetlands resources areas on or within the project site. The project site generally drains from west to east and south to north, with elevations ranging from 475 to 455 (elevations refer to NGVD 1929). The majority of the site presently drains overland toward Willard Road and Route 30. Willard Road has a limited piped drainage system near the intersection with Westboro Road and one cross drain at the southern end of the project limits near Jumbo's Path.

United States Department of Agriculture Natural Resources Conservation Service (NRCS) mapping identifies the soils of the subject site as Paxton fine sandy loam (Hydrologic Soil Group C, HSG C), and Woodbridge fine sandy loam (HSG C). Soil testing was is scheduled to be performed by Waterman Design Associates, Inc. to verify the NRCS mapping. Refer to the attached Existing Hydrology Plan for soil type delineations and testing locations.

No portion of the subject site contains an area of Priority Habitat of Rare Species or Estimated Habitat of Rare Wildlife as shown on Massachusetts Natural Heritage Atlas, 13th Edition, effective October 1, 2008. No portion of the subject site contains Special Flood Hazard Area (i.e., 100-year flood zone), as shown on the NFIP Flood Insurance Rate Map for Worcester County, Massachusetts (Map Number 25027C0831F, Effective Date July 16, 2014).

The attached Existing Hydrology Plan shows the project design points and contributing drainage area(s) with existing cover types. The analyzed design points are at the northern end of the project site near Willard Road and at the southern end of the project site near the intersection of Willard Road and Jumbo's Path.

PROPOSED PROJECT

The project proponent, Tufts University, proposes to demolish of an existing equine housing building (barn) and numerous outdoor paddocks, and construct two adjoining structures totaling 14,400 square feet along with new parking and driveway areas as well as new paddocks.

Stormwater runoff from the proposed project will be collected in deep-sump, hooded catch basins and conveyed to either an infiltration system located under the northern parking area (that is presently under construction) or directly to the existing site stormwater system. Runoff from the rooftops will be collected and directed to one of two infiltration systems adjacent to the proposed buildings.

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Controlled outflow will be discharged to the existing drainage system at rates equal to or less than existing conditions for the 2-, 10-, and 100-year, 24-hour design storms. In addition, runoff will be directed to subsurface infiltration systems to infiltrate the required volume to meet the requirements of the Town of Grafton and MassDEP Stormwater Management Standard #3 to approximate existing groundwater recharge.

Low Impact Development (LID) Considerations:

The Tufts campus is, in itself, a low impact development. In keeping with the Grafton Campus Development Overlay District regulations, the total impervious area within a 1000-foot radius of the proposed development has been calculated. In this instance only 24.4% of the roughly 70 acres is impervious.

STORMWATER MANAGEMENT STANDARDS

STANDARD #1 – NO NEW UNTREATED DISCHARGES

The stormwater collection system has been designed such that all stormwater runoff from the parking areas are treated through a treatment train consisting of deep-sump, hooded catch basins, stormwater treatment unit, sediment forebay, and infiltration basin. Additionally, all outlets have been designed so that there will be no erosion or scour to the wetlands of the Commonwealth.

STANDARD #2 – PEAK RATE ATTENUATION

METHODOLOGY

United States Soil Conservation Service, “Urban Hydrology for Small Watersheds, Technical Release Number 55” (TR-55) methods (HydroCAD 10.00) were utilized to develop runoff hydrographs for watershed areas affected by the proposed development. Existing and proposed runoff hydrographs were developed for the 2-, 10-, and 100-year, 24-hour rainfall events for the purpose of developing a stormwater management system that will limit post-development peak runoff rates to pre-development levels.

The proposed stormwater management system has been designed to meet the requirements of the Town of Grafton and the MassDEP Stormwater Management Standards. The project will limit peak rates of runoff from the site and will infiltrate runoff to approximate existing groundwater recharge.

ANALYSIS SUMMARY

In order to assess the impact of the proposed development on peak runoff rates onto down-gradient properties, hydrologic calculations were performed for each of three (3) design storms at the two (2) design points. Calculations of peak runoff rates for existing and proposed site conditions are included and summarized in Table I for each design point for the three (3) design storms. A proposed hydrology plan is provided showing the various sub-watersheds draining to the proposed stormwater management facilities. Stormwater runoff from the overland areas not tributary to the stormwater management facilities will drain by sheet flow or shallow concentrated flow along the existing flow patterns to the design points.

Table I demonstrates that the proposed stormwater management system will be effective in limiting peak rates of runoff from the subject property to approximate pre-development levels.

TABLE I: EXISTING AND PROPOSED PEAK RUNOFF

DRAINAGE AREA	DESIGN STORM EVENT / PEAK RUNOFF (cfs)		
	2-Year	10-Year	100-Year
EDA-1	5.8	10.9	18.2
PDA-1	4.2	8.8	14.5
EDA-2	1.1	2.3	4.1
PDA-2	1.0	2.0	4.0

TABLE II: EXISTING AND PROPOSED RUNOFF VOLUMES

DRAINAGE AREA	DESIGN STORM / RUNOFF VOLUME (ac-ft)		
	2-Year	10-Year	100-Year
EDA-1	0.42	0.79	1.35
PDA-1	0.43	0.83	1.41
EDA-2	0.08	0.17	0.30
PDA-2	0.07	0.17	0.31

TABLE III: MAXIMUM WATER ELEVATION

STORMWATER FACILITY	100-YEAR STORM EVENT WATER ELEVATION	TOP / BERM ELEVATION
SIS-102	455.9	456
SIS-103	463.7	464
SIS-202	463.7	464

STANDARD #3 – STORMWATER RECHARGE

Groundwater recharge is provided within the subsurface infiltration system and within the proposed infiltration basin. The soils across the site and within areas of proposed infiltration facilities are mapped as poorly drained, fine sandy loam with the characteristics of Hydrologic Soil Group C, (HSG C) soils. Using the Rawls Rates for Sandy Clay Loam (to be conservative), an exfiltration rate of 0.17 inches/hour was used in our hydrologic models for the stormwater infiltration systems. The Static Method was used in sizing the infiltration system.

The table below provides a summary of the attached groundwater recharge calculations. Calculations are based on HSG C. The required volume of groundwater recharge is equal to 0.25 inches over the additional impervious area.

REQUIRED (CF)	PROVIDED (CF)
1,150*	3,960†

* 64,395 SF additional impervious (includes rooftop)

† total volume below outlet invert in three SIS's

CAPTURE AREA ADJUSTMENT

Total Additional Impervious Area = 64,395 sf

Impervious Area Draining to Infiltration Facilities = 44,230 sf

Ratio = 64,395 / 44,230 = 1.46

*Adjusted Required Infiltration Volume (Rv) = 1.46 x 1,150 cf = 1,675 cf

ADJUSTED REQUIRED (CF)	PROVIDED (CF)
1,675	3,960

DRAWDOWN CALCULATIONS

$$Time = \frac{Rv}{(K)(BottomArea)}$$

Rv = Storage Volume (cubic feet)

K = Saturated Hydraulic Conductivity (inches per hour)

$$Time = \frac{1,675cf}{(0.17in/hr)(1ft/12in)(7,600sf)}$$

Time = 15.6 hours < 72 hours required

STANDARD #4 – WATER QUALITY

Water quality measures are designed to provide a minimum of 80% Total Suspended Solids (TSS) removal, and to treat 0.5 inch of runoff prior to discharging to the upland areas. The water quality volume is achieved by providing a static storage volume below the outlet in the subsurface infiltration facilities.

REQUIRED (CF)	PROVIDED (CF)
2,300	3,960

TSS removal is provided through the use of deep-sump, hooded catch basins and a subsurface stormwater infiltration system.

STANDARD #5 – LAND USES WITH HIGHER POTENTIAL POLLUTANT LOADS (LUHPPLS)

The proposed project is not considered a land use with Higher Potential Pollutant Loads therefore, Standard #5 is not applicable.

STANDARD #6 – CRITICAL AREAS

The proposed project is not discharging near or to a Critical Area therefore, Standard #6 is not applicable.

STANDARD #7 – REDEVELOPMENT PROJECT

The proposed project is considered a redevelopment project.

STANDARD #8 – CONSTRUCTION POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL

As the total project area is over one acre, a Notice of Intent (NOI) must be filed with the US EPA and a Stormwater Pollution Prevention Plan (SWPPP) shall be retained on-site during construction.

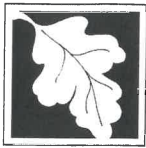
STANDARD #9 – OPERATION AND MAINTENANCE PLAN

The attached Operation and Maintenance Plan describes the requisite long-term operation and maintenance of all on-site stormwater Best Management Practices (BMPs) and hydraulic drainage system. The Operation and Maintenance Plan also describes source control for the prevention of pollution to also serve as the Long Term Pollution Prevention Plan (LTPPP).

STANDARD #10 – PROHIBITION OF ILLICIT DISCHARGES

There are no known or proposed Illicit Discharges. Any existing Illicit Discharges discovered during construction shall be disconnected and properly rerouted to sanitary sewer or a holding tank prior to the discharge of stormwater to post-construction BMPs.

MASSACHUSETTS STORMWATER REPORT CHECKLIST (follows)



Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

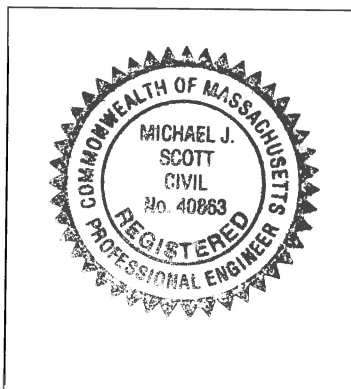
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



Signature and Date

[Handwritten Signature] 3.29.16

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

- ☐ New development
- ☒ Redevelopment
- ☐ Mix of New Development and Redevelopment



Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
 - ☐ Credit 1
 - ☐ Credit 2
 - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.



Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

- ☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- ☒ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
- ☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

- ☒ Soil Analysis provided.
- ☒ Required Recharge Volume calculation provided.
- ☐ Required Recharge volume reduced through use of the LID site Design Credits.
- ☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.
 - ☒ Static
 - ☐ Simple Dynamic
 - ☐ Dynamic Field¹
- ☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.
- ☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- ☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- ☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
 - ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
 - ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
 - ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
 - ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- ☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- ☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

¹ 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.



Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

- ☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
- ☒ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
 - Provisions for storing materials and waste products inside or under cover;
 - Vehicle washing controls;
 - Requirements for routine inspections and maintenance of stormwater BMPs;
 - Spill prevention and response plans;
 - Provisions for maintenance of lawns, gardens, and other landscaped areas;
 - Requirements for storage and use of fertilizers, herbicides, and pesticides;
 - Pet waste management provisions;
 - Provisions for operation and management of septic systems;
 - Provisions for solid waste management;
 - Snow disposal and plowing plans relative to Wetland Resource Areas;
 - Winter Road Salt and/or Sand Use and Storage restrictions;
 - Street sweeping schedules;
 - Provisions for prevention of illicit discharges to the stormwater management system;
 - Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
 - Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
 - List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- ☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
 - ☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
 - ☐ is within the Zone II or Interim Wellhead Protection Area
 - ☐ is near or to other critical areas
 - ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
 - ☐ involves runoff from land uses with higher potential pollutant loads.
 - ☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.
 - ☐ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.



Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

- ☒ The BMP is sized (and calculations provided) based on:
 - ☒ The ½" or 1" Water Quality Volume or
 - ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- ☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- ☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

- ☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.
- ☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted **prior to** the discharge of stormwater to the post-construction stormwater BMPs.
- ☐ The NPDES Multi-Sector General Permit does **not** cover the land use.
- ☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
- ☐ All exposure has been eliminated.
- ☐ All exposure has **not** been eliminated and all BMPs selected are on MassDEP LUHPPL list.
- ☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

- ☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
- ☐ Critical areas and BMPs are identified in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

- ☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
- ☐ Limited Project
 - ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
 - ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
 - ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
 - ☐ Bike Path and/or Foot Path
 - ☒ Redevelopment Project
 - ☐ Redevelopment portion of mix of new and redevelopment.
- ☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
- ☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
 - Construction Period Operation and Maintenance Plan;
 - Names of Persons or Entity Responsible for Plan Compliance;
 - Construction Period Pollution Prevention Measures;
 - Erosion and Sedimentation Control Plan Drawings;
 - Detail drawings and specifications for erosion control BMPs, including sizing calculations;
 - Vegetation Planning;
 - Site Development Plan;
 - Construction Sequencing Plan;
 - Sequencing of Erosion and Sedimentation Controls;
 - Operation and Maintenance of Erosion and Sedimentation Controls;
 - Inspection Schedule;
 - Maintenance Schedule;
 - Inspection and Maintenance Log Form.
- ☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

- ☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has **not** been included in the Stormwater Report but will be submitted **before** land disturbance begins.
- ☐ The project is **not** covered by a NPDES Construction General Permit.
- ☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
- ☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

- ☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
 - ☐ Name of the stormwater management system owners;
 - ☐ Party responsible for operation and maintenance;
 - ☐ Schedule for implementation of routine and non-routine maintenance tasks;
 - ☐ Plan showing the location of all stormwater BMPs maintenance access areas;
 - ☐ Description and delineation of public safety features;
 - ☐ Estimated operation and maintenance budget; and
 - ☐ Operation and Maintenance Log Form.
- ☐ The responsible party is **not** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
 - ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
 - ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

- ☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- ☒ An Illicit Discharge Compliance Statement is attached;
- ☐ NO Illicit Discharge Compliance Statement is attached but will be submitted **prior to** the discharge of any stormwater to post-construction BMPs.

STORMWATER MANAGEMENT SYSTEM
OPERATION AND MAINTENANCE PLAN
LONG TERM POLLUTION PREVENTION PLAN

Equine Arena
Cummings School of Veterinary Medicine
North Grafton, MA

March 2016

PREPARED FOR:

Tufts University
200 Westborough Drive
North Grafton, Massachusetts

RESPONSIBILITY:

Owner or assigns will be responsible for implementation of the Operation and Maintenance Plan for the stormwater management system and Long Term Pollution Prevention Plan for the Equine Arena and for any corrective action required.

SITE CONDITIONS:

The stormwater management system for the site includes deep sump, hooded catch basins, closed drainage system, and three (3) subsurface stormwater infiltration systems.

DEEP SUMP CATCH BASINS:

1. Catch basins shall be inspected four (4) times per year and cleaned whenever depth of sediment is greater than twenty-four (24) inches.
2. All sediments and hydrocarbons shall be properly handled and disposed in accordance with local, state, and federal guidelines and regulations.

SUBSURFACE STORMWATER INFILTRATION SYSTEMS:

1. Inspection ports are provided to allow for observation and cleaning of subsurface facilities.
2. Facilities shall be inspected at least twice per year and after the first several rainfall events and after all major storms. Pondered water inside the infiltration facilities after several days may indicate the bottom of the system is clogged.
3. Downhill slopes from infiltration areas shall be monitored weekly during construction and monthly thereafter for the first year of operation for signs of breakout. Seepage from downhill slopes shall be an indication of a system failure and corrective action shall be taken.

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4. Corrective action for system failure shall include removal and replacement of all stone aggregate and filter fabric. Accumulated sediment shall be removed from the trench bottom and the bottom shall be scarified or tilled to help induce infiltration.

SPILL CONTAINMENT:

1. In the event of a reportable spill, the Owner or its representative shall be responsible for protecting system inlets in a timely manner and notifying the appropriate authorities of the spill. In the event that spill materials enter the stormwater management system, the Owner shall be responsible for spill removal and restoration of the basin to its original condition in accordance with all applicable local and state regulations.

LAWN/LANDSCAPE MAINTENANCE:

1. Apply pesticides and fertilizers properly; at the proper time of year and at proper application rates to ensure absorption.
2. Limit lawn watering: chose drought-tolerant landscaping and grasses, and use mulch and compost to retain moisture.
3. Under no circumstance shall the stormwater management system be used for yard waste and landscape debris.

DEICING:

1. The use and loading rates for application of deicing salts should be limited to the minimum required to maintain safe vehicular and pedestrian travel.
2. Alternative materials such as sand, calcium chloride, and calcium magnesium acetate should be considered in areas adjacent stormwater management facilities and resource areas.
3. Deicing materials shall be covered to prevent loss and migration.

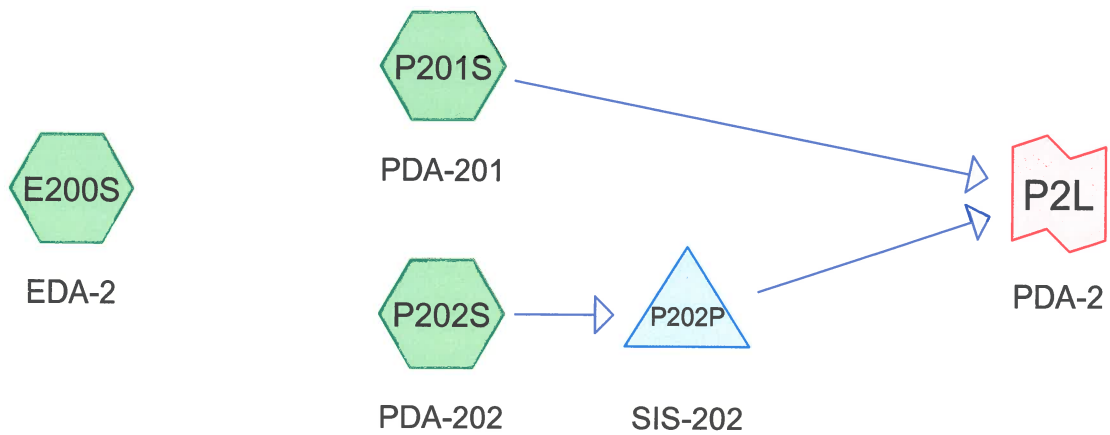
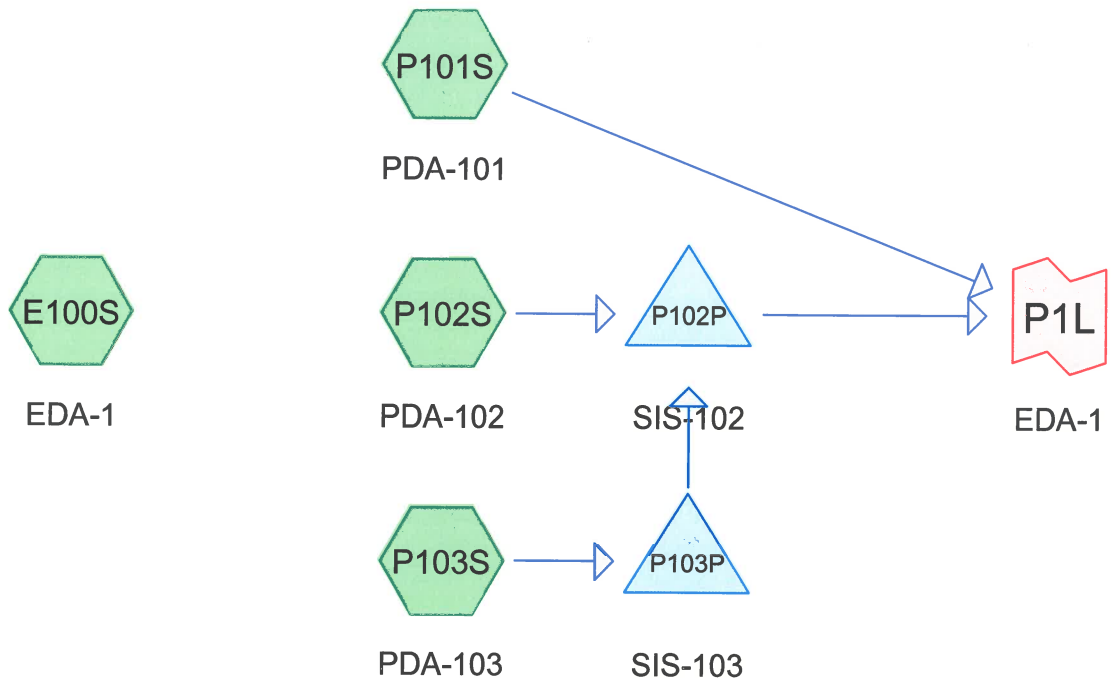
SNOW MANAGEMENT:

1. Snow shall be stockpiled in pervious areas where it can slowly infiltrate. Under no circumstance shall the stormwater management system be used for snow storage.
2. Avoid dumping/piling snow over catch basins or in drainage channels to prevent blockages and localized flooding of the drainage system.
3. The Owner shall be responsible to manage snow storage on-site and to ensure that snow is not stockpiled in the basins.
4. Sediments deposited from the snow storage areas shall be removed every spring.

SWEEPING OF PAVED SURFACES:

1. All paved surfaces on-site including driveways, loading areas, and parking areas shall be swept at least once annually to remove accumulations of sand, silt, leaves, and other debris.
2. Sweeping should occur in March/April after snowmelt has occurred and thaw has begun. Sweepings shall be disposed of at an appropriate location away from resource areas (wetlands or waterways) and stormwater management facilities.

EXISTING & PROPOSED HYDROLOGY



1614 Equine Arena

Type III 24-hr 2-year Rainfall=3.20"

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E100S: EDA-1	Runoff Area=143,235 sf 35.06% Impervious Runoff Depth>1.54" Tc=6.0 min CN=82 Runoff=5.8 cfs 0.421 af
Subcatchment E200S: EDA-2	Runoff Area=34,655 sf 14.64% Impervious Runoff Depth>1.27" Tc=6.0 min CN=78 Runoff=1.1 cfs 0.084 af
Subcatchment P101S: PDA-101	Runoff Area=77,470 sf 62.35% Impervious Runoff Depth>2.08" Tc=6.0 min CN=89 Runoff=4.2 cfs 0.308 af
Subcatchment P102S: PDA-102	Runoff Area=59,405 sf 48.77% Impervious Runoff Depth>1.83" Tc=6.0 min CN=86 Runoff=2.9 cfs 0.208 af
Subcatchment P103S: PDA-103	Runoff Area=7,560 sf 100.00% Impervious Runoff Depth>2.97" Tc=6.0 min CN=98 Runoff=0.5 cfs 0.043 af
Subcatchment P201S: PDA-201	Runoff Area=29,685 sf 8.52% Impervious Runoff Depth>1.27" Tc=6.0 min CN=78 Runoff=1.0 cfs 0.072 af
Subcatchment P202S: PDA-202	Runoff Area=7,700 sf 100.00% Impervious Runoff Depth>2.97" Tc=6.0 min CN=98 Runoff=0.5 cfs 0.044 af
Pond P102P: SIS-102	Peak Elev=454.43' Storage=0.092 af Inflow=2.9 cfs 0.209 af Discarded=0.0 cfs 0.025 af Primary=0.7 cfs 0.122 af Outflow=0.7 cfs 0.146 af
Pond P103P: SIS-103	Peak Elev=463.02' Storage=0.034 af Inflow=0.5 cfs 0.043 af Discarded=0.0 cfs 0.008 af Primary=0.0 cfs 0.000 af Outflow=0.0 cfs 0.009 af
Pond P202P: SIS-202	Peak Elev=463.03' Storage=0.034 af Inflow=0.5 cfs 0.044 af Discarded=0.0 cfs 0.008 af Primary=0.0 cfs 0.001 af Outflow=0.0 cfs 0.009 af
Link P1L: EDA-1	Inflow=4.2 cfs 0.430 af Primary=4.2 cfs 0.430 af
Link P2L: PDA-2	Inflow=1.0 cfs 0.073 af Primary=1.0 cfs 0.073 af
Total Runoff Area = 8.258 ac Runoff Volume = 1.181 af Average Runoff Depth = 1.72"	
58.20% Pervious = 4.806 ac 41.80% Impervious = 3.452 ac	

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Type III 24-hr 2-year Rainfall=3.20"

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Summary for Subcatchment E100S: EDA-1

Runoff = 5.8 cfs @ 12.09 hrs, Volume= 0.421 af, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
93,015	74	>75% Grass cover, Good, HSG C
49,270	98	Paved parking, HSG C
950	98	Roofs, HSG C
143,235	82	Weighted Average
93,015		64.94% Pervious Area
50,220		35.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment E200S: EDA-2

Runoff = 1.1 cfs @ 12.10 hrs, Volume= 0.084 af, Depth> 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
29,580	74	>75% Grass cover, Good, HSG C
2,095	98	Paved parking, HSG C
2,980	98	Roofs, HSG C
34,655	78	Weighted Average
29,580		85.36% Pervious Area
5,075		14.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P101S: PDA-101

Runoff = 4.2 cfs @ 12.09 hrs, Volume= 0.308 af, Depth> 2.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
29,165	74	>75% Grass cover, Good, HSG C
48,305	98	Paved parking, HSG C
77,470	89	Weighted Average
29,165		37.65% Pervious Area
48,305		62.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

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Type III 24-hr 2-year Rainfall=3.20"

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Summary for Subcatchment P102S: PDA-102

Runoff = 2.9 cfs @ 12.09 hrs, Volume= 0.208 af, Depth> 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
28,020	74	>75% Grass cover, Good, HSG C
2,415	89	Gravel roads, HSG C
27,810	98	Paved parking, HSG C
1,160	98	Roofs, HSG C
59,405	86	Weighted Average
30,435		51.23% Pervious Area
28,970		48.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P103S: PDA-103

Runoff = 0.5 cfs @ 12.09 hrs, Volume= 0.043 af, Depth> 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
7,560	98	Roofs, HSG C
7,560		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P201S: PDA-201

Runoff = 1.0 cfs @ 12.10 hrs, Volume= 0.072 af, Depth> 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
23,375	74	>75% Grass cover, Good, HSG C
2,135	98	Paved parking, HSG C
395	98	Roofs, HSG C
3,780	89	Gravel roads, HSG C
29,685	78	Weighted Average
27,155		91.48% Pervious Area
2,530		8.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

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Type III 24-hr 2-year Rainfall=3.20"

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Summary for Subcatchment P202S: PDA-202

Runoff = 0.5 cfs @ 12.09 hrs, Volume= 0.044 af, Depth> 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.20"

Area (sf)	CN	Description
7,700	98	Roofs, HSG C
7,700		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Pond P102P: SIS-102

Inflow Area = 1.537 ac, 54.55% Impervious, Inflow Depth > 1.63" for 2-year event
 Inflow = 2.9 cfs @ 12.09 hrs, Volume= 0.209 af
 Outflow = 0.7 cfs @ 12.48 hrs, Volume= 0.146 af, Atten= 74%, Lag= 23.4 min
 Discarded = 0.0 cfs @ 9.55 hrs, Volume= 0.025 af
 Primary = 0.7 cfs @ 12.48 hrs, Volume= 0.122 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 454.43' @ 12.48 hrs Surf.Area= 0.116 ac Storage= 0.092 af

Plug-Flow detention time= 179.6 min calculated for 0.146 af (70% of inflow)
 Center-of-Mass det. time= 84.6 min (907.4 - 822.8)

Volume	Invert	Avail.Storage	Storage Description
#1	453.00'	0.102 af	63.00'W x 80.00'L x 3.00'H Prismatoid 0.347 af Overall - 0.093 af Embedded = 0.254 af x 40.0% Voids
#2	453.50'	0.093 af	24.0" Round Pipe Storage x 17 Inside #1 L= 76.0'
		0.195 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	453.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	454.00'	12.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 9.55 hrs HW=453.03' (Free Discharge)
 ↑ **1=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=0.7 cfs @ 12.48 hrs HW=454.43' (Free Discharge)
 ↑ **2=Orifice/Grate** (Orifice Controls 0.7 cfs @ 2.24 fps)

Summary for Pond P103P: SIS-103

Inflow Area = 0.174 ac, 100.00% Impervious, Inflow Depth > 2.97" for 2-year event
 Inflow = 0.5 cfs @ 12.09 hrs, Volume= 0.043 af
 Outflow = 0.0 cfs @ 21.65 hrs, Volume= 0.009 af, Atten= 99%, Lag= 573.8 min
 Discarded = 0.0 cfs @ 5.80 hrs, Volume= 0.008 af
 Primary = 0.0 cfs @ 21.65 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 463.02' @ 21.65 hrs Surf.Area= 0.029 ac Storage= 0.034 af

Plug-Flow detention time= 336.5 min calculated for 0.009 af (20% of inflow)
 Center-of-Mass det. time= 96.6 min (852.6 - 756.0)

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Type III 24-hr 2-year Rainfall=3.20"

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Volume	Invert	Avail.Storage	Storage Description
#1	461.00'	0.027 af	16.00'W x 80.00'L x 3.00'H Prismaoid 0.088 af Overall - 0.022 af Embedded = 0.067 af x 40.0% Voids
#2	461.50'	0.022 af	24.0" Round Pipe Storage x 4 Inside #1 L= 75.0'
		0.048 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	461.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	463.00'	6.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 5.80 hrs HW=461.03' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)**Primary OutFlow** Max=0.0 cfs @ 21.65 hrs HW=463.02' (Free Discharge)↑**2=Orifice/Grate** (Orifice Controls 0.0 cfs @ 0.43 fps)**Summary for Pond P202P: SIS-202**

Inflow Area = 0.177 ac, 100.00% Impervious, Inflow Depth > 2.97" for 2-year event
 Inflow = 0.5 cfs @ 12.09 hrs, Volume= 0.044 af
 Outflow = 0.0 cfs @ 19.58 hrs, Volume= 0.009 af, Atten= 99%, Lag= 449.4 min
 Discarded = 0.0 cfs @ 5.75 hrs, Volume= 0.008 af
 Primary = 0.0 cfs @ 19.58 hrs, Volume= 0.001 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 463.03' @ 19.58 hrs Surf.Area= 0.029 ac Storage= 0.034 af

Plug-Flow detention time= 352.3 min calculated for 0.009 af (22% of inflow)
 Center-of-Mass det. time= 122.4 min (878.4 - 756.0)

Volume	Invert	Avail.Storage	Storage Description
#1	461.00'	0.027 af	16.00'W x 80.00'L x 3.00'H Prismaoid 0.088 af Overall - 0.022 af Embedded = 0.067 af x 40.0% Voids
#2	461.50'	0.022 af	24.0" Round Pipe Storage x 4 Inside #1 L= 75.0'
		0.048 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	461.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	463.00'	6.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 5.75 hrs HW=461.03' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)**Primary OutFlow** Max=0.0 cfs @ 19.58 hrs HW=463.03' (Free Discharge)↑**2=Orifice/Grate** (Orifice Controls 0.0 cfs @ 0.55 fps)**Summary for Link P1L: EDA-1**

Inflow Area = 3.316 ac, 58.74% Impervious, Inflow Depth > 1.56" for 2-year event
 Inflow = 4.2 cfs @ 12.09 hrs, Volume= 0.430 af
 Primary = 4.2 cfs @ 12.09 hrs, Volume= 0.430 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link P2L: PDA-2

Inflow Area = 0.858 ac, 27.36% Impervious, Inflow Depth > 1.03" for 2-year event
Inflow = 1.0 cfs @ 12.10 hrs, Volume= 0.073 af
Primary = 1.0 cfs @ 12.10 hrs, Volume= 0.073 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E100S: EDA-1	Runoff Area=143,235 sf 35.06% Impervious Runoff Depth>2.90" Tc=6.0 min CN=82 Runoff=10.9 cfs 0.794 af
Subcatchment E200S: EDA-2	Runoff Area=34,655 sf 14.64% Impervious Runoff Depth>2.54" Tc=6.0 min CN=78 Runoff=2.3 cfs 0.168 af
Subcatchment P101S: PDA-101	Runoff Area=77,470 sf 62.35% Impervious Runoff Depth>3.58" Tc=6.0 min CN=89 Runoff=7.1 cfs 0.530 af
Subcatchment P102S: PDA-102	Runoff Area=59,405 sf 48.77% Impervious Runoff Depth>3.28" Tc=6.0 min CN=86 Runoff=5.1 cfs 0.373 af
Subcatchment P103S: PDA-103	Runoff Area=7,560 sf 100.00% Impervious Runoff Depth>4.56" Tc=6.0 min CN=98 Runoff=0.8 cfs 0.066 af
Subcatchment P201S: PDA-201	Runoff Area=29,685 sf 8.52% Impervious Runoff Depth>2.54" Tc=6.0 min CN=78 Runoff=2.0 cfs 0.144 af
Subcatchment P202S: PDA-202	Runoff Area=7,700 sf 100.00% Impervious Runoff Depth>4.56" Tc=6.0 min CN=98 Runoff=0.8 cfs 0.067 af
Pond P102P: SIS-102	Peak Elev=454.92' Storage=0.132 af Inflow=5.1 cfs 0.395 af Discarded=0.0 cfs 0.028 af Primary=2.5 cfs 0.303 af Outflow=2.5 cfs 0.330 af
Pond P103P: SIS-103	Peak Elev=463.24' Storage=0.038 af Inflow=0.8 cfs 0.066 af Discarded=0.0 cfs 0.009 af Primary=0.2 cfs 0.023 af Outflow=0.2 cfs 0.031 af
Pond P202P: SIS-202	Peak Elev=463.25' Storage=0.039 af Inflow=0.8 cfs 0.067 af Discarded=0.0 cfs 0.009 af Primary=0.2 cfs 0.024 af Outflow=0.2 cfs 0.033 af
Link P1L: EDA-1	Inflow=8.8 cfs 0.833 af Primary=8.8 cfs 0.833 af
Link P2L: PDA-2	Inflow=2.0 cfs 0.168 af Primary=2.0 cfs 0.168 af

Total Runoff Area = 8.258 ac Runoff Volume = 2.143 af Average Runoff Depth = 3.11"
58.20% Pervious = 4.806 ac 41.80% Impervious = 3.452 ac

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Type III 24-hr 10-year Rainfall=4.80"

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Summary for Subcatchment E100S: EDA-1

Runoff = 10.9 cfs @ 12.09 hrs, Volume= 0.794 af, Depth> 2.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
93,015	74	>75% Grass cover, Good, HSG C
49,270	98	Paved parking, HSG C
950	98	Roofs, HSG C
143,235	82	Weighted Average
93,015		64.94% Pervious Area
50,220		35.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment E200S: EDA-2

Runoff = 2.3 cfs @ 12.09 hrs, Volume= 0.168 af, Depth> 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
29,580	74	>75% Grass cover, Good, HSG C
2,095	98	Paved parking, HSG C
2,980	98	Roofs, HSG C
34,655	78	Weighted Average
29,580		85.36% Pervious Area
5,075		14.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P101S: PDA-101

Runoff = 7.1 cfs @ 12.09 hrs, Volume= 0.530 af, Depth> 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
29,165	74	>75% Grass cover, Good, HSG C
48,305	98	Paved parking, HSG C
77,470	89	Weighted Average
29,165		37.65% Pervious Area
48,305		62.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

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Type III 24-hr 10-year Rainfall=4.80"

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Summary for Subcatchment P102S: PDA-102

Runoff = 5.1 cfs @ 12.09 hrs, Volume= 0.373 af, Depth> 3.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
28,020	74	>75% Grass cover, Good, HSG C
2,415	89	Gravel roads, HSG C
27,810	98	Paved parking, HSG C
1,160	98	Roofs, HSG C
59,405	86	Weighted Average
30,435		51.23% Pervious Area
28,970		48.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P103S: PDA-103

Runoff = 0.8 cfs @ 12.09 hrs, Volume= 0.066 af, Depth> 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
7,560	98	Roofs, HSG C
7,560		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P201S: PDA-201

Runoff = 2.0 cfs @ 12.09 hrs, Volume= 0.144 af, Depth> 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
23,375	74	>75% Grass cover, Good, HSG C
2,135	98	Paved parking, HSG C
395	98	Roofs, HSG C
3,780	89	Gravel roads, HSG C
29,685	78	Weighted Average
27,155		91.48% Pervious Area
2,530		8.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

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Type III 24-hr 10-year Rainfall=4.80"

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Summary for Subcatchment P202S: PDA-202

Runoff = 0.8 cfs @ 12.09 hrs, Volume= 0.067 af, Depth> 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.80"

Area (sf)	CN	Description
7,700	98	Roofs, HSG C
7,700		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Pond P102P: SIS-102

Inflow Area = 1.537 ac, 54.55% Impervious, Inflow Depth > 3.08" for 10-year event
 Inflow = 5.1 cfs @ 12.09 hrs, Volume= 0.395 af
 Outflow = 2.5 cfs @ 12.26 hrs, Volume= 0.330 af, Atten= 51%, Lag= 10.1 min
 Discarded = 0.0 cfs @ 7.95 hrs, Volume= 0.028 af
 Primary = 2.5 cfs @ 12.26 hrs, Volume= 0.303 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 454.92' @ 12.26 hrs Surf.Area= 0.116 ac Storage= 0.132 af

Plug-Flow detention time= 120.8 min calculated for 0.329 af (83% of inflow)
 Center-of-Mass det. time= 54.2 min (864.7 - 810.5)

Volume	Invert	Avail.Storage	Storage Description
#1	453.00'	0.102 af	63.00'W x 80.00'L x 3.00'H Prismatoid 0.347 af Overall - 0.093 af Embedded = 0.254 af x 40.0% Voids
#2	453.50'	0.093 af	24.0" Round Pipe Storage x 17 Inside #1 L= 76.0'
		0.195 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	453.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	454.00'	12.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 7.95 hrs HW=453.03' (Free Discharge)
 ↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=2.5 cfs @ 12.26 hrs HW=454.92' (Free Discharge)
 ↑**2=Orifice/Grate** (Orifice Controls 2.5 cfs @ 3.27 fps)

Summary for Pond P103P: SIS-103

Inflow Area = 0.174 ac, 100.00% Impervious, Inflow Depth > 4.56" for 10-year event
 Inflow = 0.8 cfs @ 12.09 hrs, Volume= 0.066 af
 Outflow = 0.2 cfs @ 12.52 hrs, Volume= 0.031 af, Atten= 80%, Lag= 26.1 min
 Discarded = 0.0 cfs @ 3.75 hrs, Volume= 0.009 af
 Primary = 0.2 cfs @ 12.52 hrs, Volume= 0.023 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 463.24' @ 12.52 hrs Surf.Area= 0.029 ac Storage= 0.038 af

Plug-Flow detention time= 250.9 min calculated for 0.031 af (48% of inflow)
 Center-of-Mass det. time= 117.8 min (866.1 - 748.3)

1614 Equine Arena

Type III 24-hr 10-year Rainfall=4.80"

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Volume	Invert	Avail.Storage	Storage Description
#1	461.00'	0.027 af	16.00'W x 80.00'L x 3.00'H Prismatic 0.088 af Overall - 0.022 af Embedded = 0.067 af x 40.0% Voids
#2	461.50'	0.022 af	24.0" Round Pipe Storage x 4 Inside #1 L= 75.0'
		0.048 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	461.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	463.00'	6.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 3.75 hrs HW=461.03' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)**Primary OutFlow** Max=0.1 cfs @ 12.52 hrs HW=463.23' (Free Discharge)↑**2=Orifice/Grate** (Orifice Controls 0.1 cfs @ 1.65 fps)**Summary for Pond P202P: SIS-202**

Inflow Area = 0.177 ac, 100.00% Impervious, Inflow Depth > 4.56" for 10-year event
 Inflow = 0.8 cfs @ 12.09 hrs, Volume= 0.067 af
 Outflow = 0.2 cfs @ 12.50 hrs, Volume= 0.033 af, Atten= 79%, Lag= 24.9 min
 Discarded = 0.0 cfs @ 3.70 hrs, Volume= 0.009 af
 Primary = 0.2 cfs @ 12.50 hrs, Volume= 0.024 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 463.25' @ 12.50 hrs Surf.Area= 0.029 ac Storage= 0.039 af

Plug-Flow detention time= 247.7 min calculated for 0.033 af (49% of inflow)
 Center-of-Mass det. time= 115.8 min (864.1 - 748.3)

Volume	Invert	Avail.Storage	Storage Description
#1	461.00'	0.027 af	16.00'W x 80.00'L x 3.00'H Prismatic 0.088 af Overall - 0.022 af Embedded = 0.067 af x 40.0% Voids
#2	461.50'	0.022 af	24.0" Round Pipe Storage x 4 Inside #1 L= 75.0'
		0.048 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	461.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	463.00'	6.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 3.70 hrs HW=461.03' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)**Primary OutFlow** Max=0.2 cfs @ 12.50 hrs HW=463.25' (Free Discharge)↑**2=Orifice/Grate** (Orifice Controls 0.2 cfs @ 1.70 fps)**Summary for Link P1L: EDA-1**

Inflow Area = 3.316 ac, 58.74% Impervious, Inflow Depth > 3.01" for 10-year event
 Inflow = 8.8 cfs @ 12.10 hrs, Volume= 0.833 af
 Primary = 8.8 cfs @ 12.10 hrs, Volume= 0.833 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

1614 Equine Arena

Type III 24-hr 10-year Rainfall=4.80"

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Summary for Link P2L: PDA-2

Inflow Area = 0.858 ac, 27.36% Impervious, Inflow Depth > 2.35" for 10-year event
Inflow = 2.0 cfs @ 12.09 hrs, Volume= 0.168 af
Primary = 2.0 cfs @ 12.09 hrs, Volume= 0.168 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

1614 Equine Arena*Type III 24-hr 100-year Rainfall=7.00"*

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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E100S: EDA-1	Runoff Area=143,235 sf 35.06% Impervious Runoff Depth>4.91" Tc=6.0 min CN=82 Runoff=18.2 cfs 1.346 af
Subcatchment E200S: EDA-2	Runoff Area=34,655 sf 14.64% Impervious Runoff Depth>4.47" Tc=6.0 min CN=78 Runoff=4.1 cfs 0.296 af
Subcatchment P101S: PDA-101	Runoff Area=77,470 sf 62.35% Impervious Runoff Depth>5.70" Tc=6.0 min CN=89 Runoff=11.0 cfs 0.845 af
Subcatchment P102S: PDA-102	Runoff Area=59,405 sf 48.77% Impervious Runoff Depth>5.36" Tc=6.0 min CN=86 Runoff=8.1 cfs 0.609 af
Subcatchment P103S: PDA-103	Runoff Area=7,560 sf 100.00% Impervious Runoff Depth>6.76" Tc=6.0 min CN=98 Runoff=1.2 cfs 0.098 af
Subcatchment P201S: PDA-201	Runoff Area=29,685 sf 8.52% Impervious Runoff Depth>4.47" Tc=6.0 min CN=78 Runoff=3.5 cfs 0.254 af
Subcatchment P202S: PDA-202	Runoff Area=7,700 sf 100.00% Impervious Runoff Depth>6.76" Tc=6.0 min CN=98 Runoff=1.2 cfs 0.100 af
Pond P102P: SIS-102	Peak Elev=455.89' Storage=0.190 af Inflow=8.5 cfs 0.663 af Discarded=0.0 cfs 0.030 af Primary=4.5 cfs 0.565 af Outflow=4.5 cfs 0.595 af
Pond P103P: SIS-103	Peak Elev=463.71' Storage=0.045 af Inflow=1.2 cfs 0.098 af Discarded=0.0 cfs 0.009 af Primary=0.6 cfs 0.054 af Outflow=0.6 cfs 0.063 af
Pond P202P: SIS-202	Peak Elev=463.74' Storage=0.045 af Inflow=1.2 cfs 0.100 af Discarded=0.0 cfs 0.009 af Primary=0.7 cfs 0.055 af Outflow=0.7 cfs 0.065 af
Link P1L: EDA-1	Inflow=14.5 cfs 1.411 af Primary=14.5 cfs 1.411 af
Link P2L: PDA-2	Inflow=4.0 cfs 0.309 af Primary=4.0 cfs 0.309 af

Total Runoff Area = 8.258 ac Runoff Volume = 3.548 af Average Runoff Depth = 5.16"
58.20% Pervious = 4.806 ac 41.80% Impervious = 3.452 ac

1614 Equine Arena

Type III 24-hr 100-year Rainfall=7.00"

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Summary for Subcatchment E100S: EDA-1

Runoff = 18.2 cfs @ 12.09 hrs, Volume= 1.346 af, Depth> 4.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
93,015	74	>75% Grass cover, Good, HSG C
49,270	98	Paved parking, HSG C
950	98	Roofs, HSG C
143,235	82	Weighted Average
93,015		64.94% Pervious Area
50,220		35.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment E200S: EDA-2

Runoff = 4.1 cfs @ 12.09 hrs, Volume= 0.296 af, Depth> 4.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
29,580	74	>75% Grass cover, Good, HSG C
2,095	98	Paved parking, HSG C
2,980	98	Roofs, HSG C
34,655	78	Weighted Average
29,580		85.36% Pervious Area
5,075		14.64% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P101S: PDA-101

Runoff = 11.0 cfs @ 12.09 hrs, Volume= 0.845 af, Depth> 5.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
29,165	74	>75% Grass cover, Good, HSG C
48,305	98	Paved parking, HSG C
77,470	89	Weighted Average
29,165		37.65% Pervious Area
48,305		62.35% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

1614 Equine Arena

Type III 24-hr 100-year Rainfall=7.00"

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Summary for Subcatchment P102S: PDA-102

Runoff = 8.1 cfs @ 12.09 hrs, Volume= 0.609 af, Depth> 5.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
28,020	74	>75% Grass cover, Good, HSG C
2,415	89	Gravel roads, HSG C
27,810	98	Paved parking, HSG C
1,160	98	Roofs, HSG C
59,405	86	Weighted Average
30,435		51.23% Pervious Area
28,970		48.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P103S: PDA-103

Runoff = 1.2 cfs @ 12.09 hrs, Volume= 0.098 af, Depth> 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
7,560	98	Roofs, HSG C
7,560		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment P201S: PDA-201

Runoff = 3.5 cfs @ 12.09 hrs, Volume= 0.254 af, Depth> 4.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
23,375	74	>75% Grass cover, Good, HSG C
2,135	98	Paved parking, HSG C
395	98	Roofs, HSG C
3,780	89	Gravel roads, HSG C
29,685	78	Weighted Average
27,155		91.48% Pervious Area
2,530		8.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

1614 Equine Arena

Type III 24-hr 100-year Rainfall=7.00"

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Summary for Subcatchment P202S: PDA-202

Runoff = 1.2 cfs @ 12.09 hrs, Volume= 0.100 af, Depth> 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
7,700	98	Roofs, HSG C
7,700		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Pond P102P: SIS-102

Inflow Area = 1.537 ac, 54.55% Impervious, Inflow Depth > 5.18" for 100-year event
 Inflow = 8.5 cfs @ 12.09 hrs, Volume= 0.663 af
 Outflow = 4.5 cfs @ 12.26 hrs, Volume= 0.595 af, Atten= 47%, Lag= 10.0 min
 Discarded = 0.0 cfs @ 6.35 hrs, Volume= 0.030 af
 Primary = 4.5 cfs @ 12.26 hrs, Volume= 0.565 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 455.89' @ 12.26 hrs Surf.Area= 0.116 ac Storage= 0.190 af

Plug-Flow detention time= 93.1 min calculated for 0.595 af (90% of inflow)
 Center-of-Mass det. time= 44.5 min (840.5 - 796.1)

Volume	Invert	Avail.Storage	Storage Description
#1	453.00'	0.102 af	63.00'W x 80.00'L x 3.00'H Prismatoid 0.347 af Overall - 0.093 af Embedded = 0.254 af x 40.0% Voids
#2	453.50'	0.093 af	24.0" Round Pipe Storage x 17 Inside #1 L= 76.0'
		0.195 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	453.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	454.00'	12.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 6.35 hrs HW=453.03' (Free Discharge)
 ↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=4.5 cfs @ 12.26 hrs HW=455.89' (Free Discharge)
 ↑**2=Orifice/Grate** (Orifice Controls 4.5 cfs @ 5.67 fps)

Summary for Pond P103P: SIS-103

Inflow Area = 0.174 ac, 100.00% Impervious, Inflow Depth > 6.76" for 100-year event
 Inflow = 1.2 cfs @ 12.09 hrs, Volume= 0.098 af
 Outflow = 0.6 cfs @ 12.22 hrs, Volume= 0.063 af, Atten= 45%, Lag= 7.8 min
 Discarded = 0.0 cfs @ 2.45 hrs, Volume= 0.009 af
 Primary = 0.6 cfs @ 12.22 hrs, Volume= 0.054 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 463.71' @ 12.22 hrs Surf.Area= 0.029 ac Storage= 0.045 af

Plug-Flow detention time= 195.9 min calculated for 0.063 af (64% of inflow)
 Center-of-Mass det. time= 91.0 min (833.5 - 742.5)

1614 Equine Arena

Type III 24-hr 100-year Rainfall=7.00"

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Volume	Invert	Avail.Storage	Storage Description
#1	461.00'	0.027 af	16.00'W x 80.00'L x 3.00'H Prismatoid 0.088 af Overall - 0.022 af Embedded = 0.067 af x 40.0% Voids
#2	461.50'	0.022 af	24.0" Round Pipe Storage x 4 Inside #1 L= 75.0'
		0.048 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	461.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	463.00'	6.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 2.45 hrs HW=461.03' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)**Primary OutFlow** Max=0.6 cfs @ 12.22 hrs HW=463.70' (Free Discharge)↑**2=Orifice/Grate** (Orifice Controls 0.6 cfs @ 3.23 fps)**Summary for Pond P202P: SIS-202**

Inflow Area = 0.177 ac, 100.00% Impervious, Inflow Depth > 6.76" for 100-year event
 Inflow = 1.2 cfs @ 12.09 hrs, Volume= 0.100 af
 Outflow = 0.7 cfs @ 12.21 hrs, Volume= 0.065 af, Atten= 44%, Lag= 7.7 min
 Discarded = 0.0 cfs @ 2.40 hrs, Volume= 0.009 af
 Primary = 0.7 cfs @ 12.21 hrs, Volume= 0.055 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
 Peak Elev= 463.74' @ 12.21 hrs Surf.Area= 0.029 ac Storage= 0.045 af

Plug-Flow detention time= 193.0 min calculated for 0.065 af (65% of inflow)
 Center-of-Mass det. time= 90.2 min (832.7 - 742.5)

Volume	Invert	Avail.Storage	Storage Description
#1	461.00'	0.027 af	16.00'W x 80.00'L x 3.00'H Prismatoid 0.088 af Overall - 0.022 af Embedded = 0.067 af x 40.0% Voids
#2	461.50'	0.022 af	24.0" Round Pipe Storage x 4 Inside #1 L= 75.0'
		0.048 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	461.00'	0.170 in/hr Exfiltration over Surface area
#2	Primary	463.00'	6.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.0 cfs @ 2.40 hrs HW=461.03' (Free Discharge)↑**1=Exfiltration** (Exfiltration Controls 0.0 cfs)**Primary OutFlow** Max=0.7 cfs @ 12.21 hrs HW=463.73' (Free Discharge)↑**2=Orifice/Grate** (Orifice Controls 0.7 cfs @ 3.35 fps)**Summary for Link P1L: EDA-1**

Inflow Area = 3.316 ac, 58.74% Impervious, Inflow Depth > 5.11" for 100-year event
 Inflow = 14.5 cfs @ 12.10 hrs, Volume= 1.411 af
 Primary = 14.5 cfs @ 12.10 hrs, Volume= 1.411 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link P2L: PDA-2

Inflow Area = 0.858 ac, 27.36% Impervious, Inflow Depth > 4.33" for 100-year event
Inflow = 4.0 cfs @ 12.10 hrs, Volume= 0.309 af
Primary = 4.0 cfs @ 12.10 hrs, Volume= 0.309 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

APPENDICES



MAP SCALE 1" = 500'



NFIP **NATIONAL FLOOD INSURANCE PROGRAM**

PANEL 0831F

FIRM

FLOOD INSURANCE RATE MAP
WORCESTER COUNTY,
MASSACHUSETTS
(ALL JURISDICTIONS)

PANEL 831 OF 1075
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:	NUMBERS	PANEL	SUFFIX
COMMUNITY	250306	0831	F
GRAFTON, TOWN OF		0831	F
WESTBOROUGH, TOWN OF	250344		

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

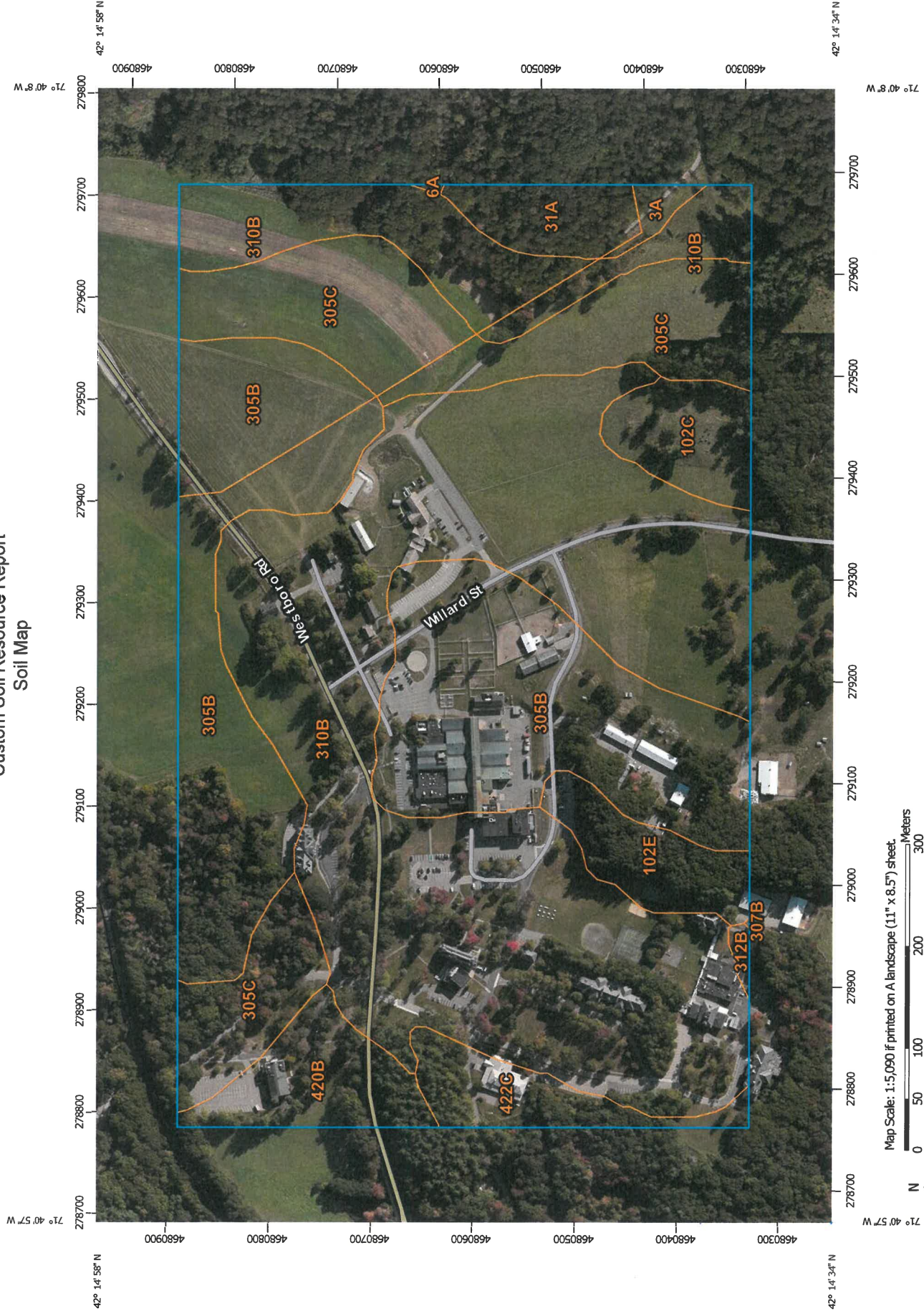


MAP NUMBER
25027C0831F
MAP REVISED
JULY 16, 2014

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Custom Soil Resource Report Soil Map



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spill Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 10, Sep 28, 2015

Soil Survey Area: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 8, Sep 28, 2015

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

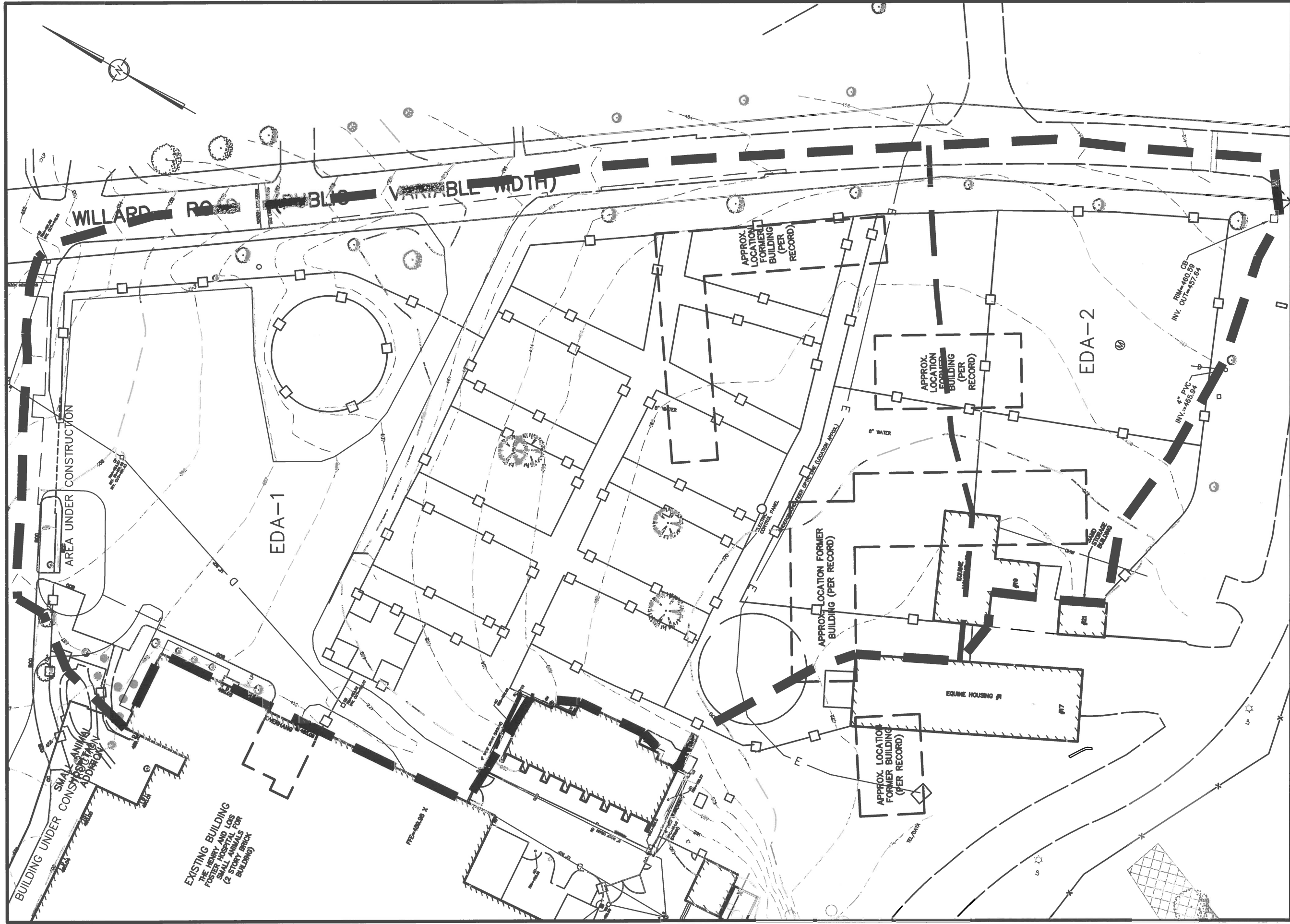
Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

Custom Soil Resource Report

Map Unit Legend

Worcester County, Massachusetts, Northeastern Part (MA613)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	0.0	0.0%
31A	Walpole sandy loam, 0 to 3 percent slopes	2.7	2.1%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	5.0	3.9%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	6.6	5.1%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	6.6	5.1%
Subtotals for Soil Survey Area		20.9	16.2%
Totals for Area of Interest		128.7	100.0%

Worcester County, Massachusetts, Southern Part (MA615)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
3A	Scarboro and Walpole soils, 0 to 3 percent slopes	0.6	0.5%
102C	Chatfield-Hollis-Rock outcrop complex, 3 to 15 percent slopes	3.5	2.7%
102E	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	3.6	2.8%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	27.4	21.3%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	10.5	8.2%
307B	Paxton fine sandy loam, 0 to 8 percent slopes, extremely stony	0.0	0.0%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	54.0	41.9%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	0.2	0.2%
420B	Canton fine sandy loam, 3 to 8 percent slopes	4.5	3.5%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	3.5	2.7%
Subtotals for Soil Survey Area		107.8	83.8%
Totals for Area of Interest		128.7	100.0%



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TITLE:

EXISTING HYDROLOGY PLAN

Willard Road
North Grafton, MA

PREPARED FOR:

THE CUMMINGS SCHOOL OF VETERINARY MEDICINE AT TUFTS UNIVERSITY

200 Westborough Drive
North Grafton, MA

DATE:

3/30/16

JOB NO.:

0016.14

FILE NO.:

0016380

DWG NO.:

0016381A

REV. NO.:

A

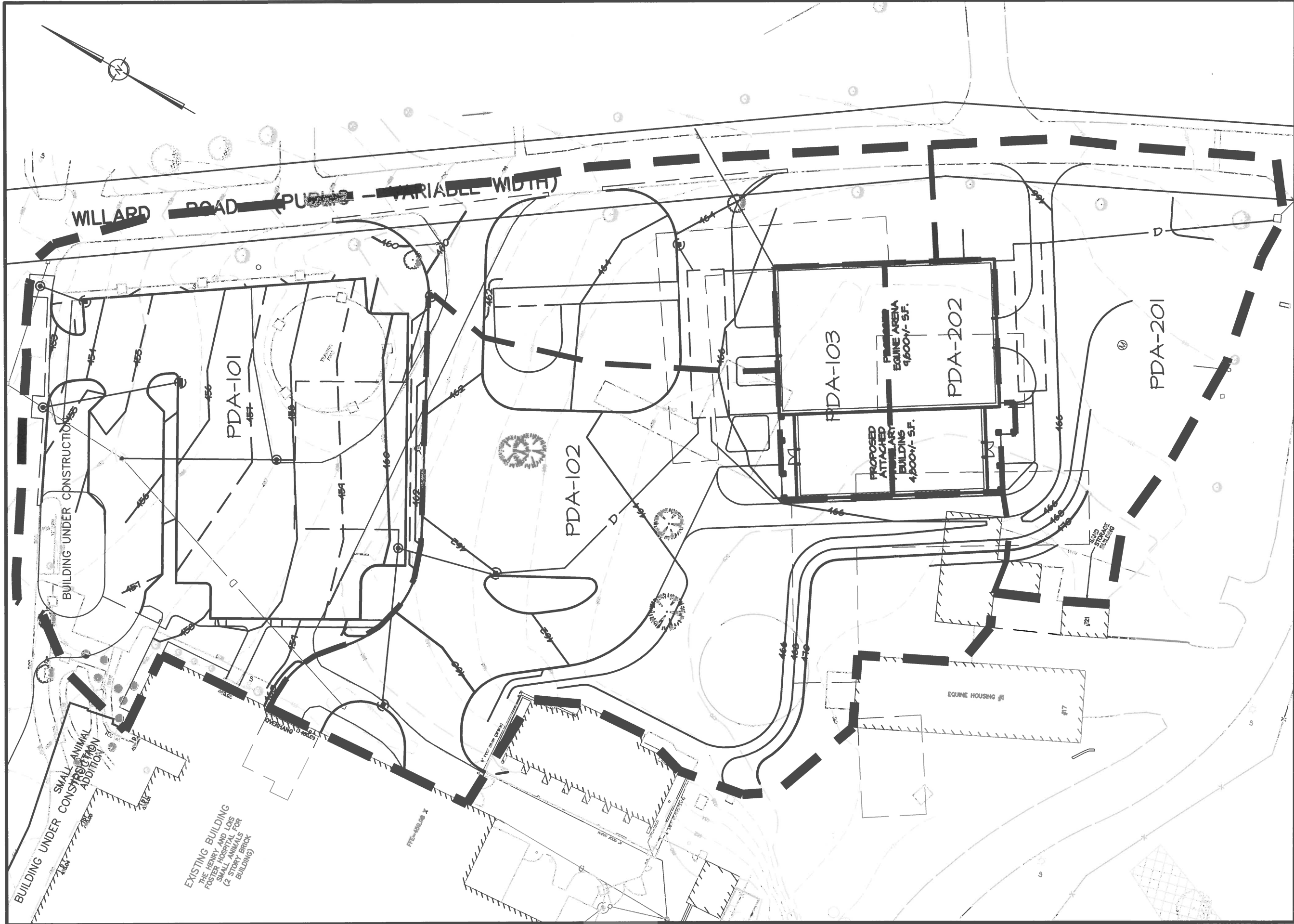
SCALE:

1" = 50'

DRAWN BY:

MIS

REV. DATE:



PREPARED BY:	TITLE: PROPOSED HYDROLOGY PLAN			
	Willard Road North Grafton, MA			
PREPARED FOR:	THE CUMMINGS SCHOOL OF VETERINARY MEDICINE AT TUFTS UNIVERSITY			
	200 Westborough Drive North Grafton, MA			
DATE:	3/30/16	FILE NO.:	0016380	SCALE: 1" = 50'
JOB NO.:	0016.14	DWG NO.:	0016382A	DRAWN BY: MIS
		REV. NO.:	A	REV. DATE:

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